

### **Amendments to the Specification**

Please replace the first paragraph on page 2 with the following amended paragraph:

It is a further object of this invention to provide compact optical switch designs that scale linearly with the number of inputs.

Please replace the last paragraph on page 6, continuing onto page 7, with the following amended paragraph:

In one embodiment of a multiple input optical switch of this invention, each directing element includes two groups of sections. In each group, each section includes a switchable volume grating having the same blazing state and capable of deviating an input beam in the direction consistent with that blazing state. Figures 2(a) depicts all possible switching paths of an embodiment of a four (4) input optical switch 100 of this invention in which each directing element includes two groups of sections and figures 2(b) through 2(f) depict some of the possible states of that embodiment of a four (4) input optical switch 100 of this invention. Referring to Fig. 2(a), two input beams 102, 104 are received by two upper sections of a first directing element 110 and two other beams 106, 108 are received by two lower sections of the first directing element 110. Referring to Fig. 2~~(d)~~(e), the switchable grating in each of the two upper sections 112, 114 of the first directing element 110 is capable of deviating the corresponding input beam 102, 104 in a first direction corresponding to a blazing state similar to that of Figs. 1a, 1b (hereinafter referred to as the first direction). Also referring to Fig. 2~~(d)~~(e), the switchable grating in each of the two lower sections 116, 118 of the first directing element 110 is capable of deviating the corresponding input beam 106, 108 in a second direction corresponding to a blazing state similar to that of Figs. 1c, 1d (hereinafter referred to as the second direction).

Please replace the second paragraph on page 12 with the following amended paragraphs:

While in the above described embodiments 100, 200 of the optical switch of this invention the number of sections is even, embodiments are possible with an odd number of sections. In an embodiment with an odd number of sections, the last section is considered as an incomplete repeat of sections above the last section. That is, the last section is considered as the first section in another set of two groups of multiple sections, as in the generalized embodiment of the optical switch 100 of Fig. 2(a-f); or, the last section is considered as first section in group of two sections, as in the generalized embodiment of the optical switch 200 of Fig. 3(a-f). Succeeding elements repeat the pattern as described above. If  $N$  is the odd number of sections, where  $N$  is greater than one, then the generalized embodiment has  $N+1$  directing elements.

Please replace the second and third paragraphs on page 13 with the following amended paragraphs:

Referring to Fig. 5, two input beams 401, 402 are received by the upper group, the two upper sections of the first directing element 410 and two other input beams 403, 404 are received by the lower group, the two lower sections, of the first directing element 410. Referring again to Fig. 5, the switchable grating in each of the two upper sections 411, 412 of the first directing element 410 is capable of deviating the corresponding input beam 401, 402 in the first direction. The switchable grating in each of the two lower sections 413, 414 of the first directing element 410 is capable of deviating the corresponding input beam 403, 404 in the second direction.

Also referring to Fig. 5, the switchable grating in the upper section 422 of the second directing element 420 is capable of deviating one of the beams transmitted through the first directing element 410 in the second direction. The switchable

grating in the lower section 423 of the second directing element 420 is capable of deviating another one of the beams transmitted through the first directing element 410 in the first direction.

Please replace the only paragraph on page 16 with the following amended paragraph:

An isometric view of the above described embodiment of the 4X4 optical switch 400 of this invention is shown in Fig. 6. A multiple layer embodiment of the optical switch 500 of this invention is shown in Fig. 7. A first lower directing element 510 is disposed below said first directing element 410. Successive lower directing elements 520, 530, 540, 550 are disposed below the corresponding upper directing element 420, 430, 440, 450. In such a manner a replica of the 4X4 embodiment of the optical switch 400 of this invention is disposed below the upper 4X4 embodiment of the optical switch 400. Similarly, several other replicas of the 4X4 embodiment of the optical switch 400 of this invention ~~are~~ can be stacked to obtain the multiple layer embodiment of the optical switch 500 of this invention shown in Fig. 7.

Please replace the paragraph on page 18, continuing onto page 19, with the following amended paragraphs:

In the multiple layer embodiment of the optical switch 600 of this invention shown in Fig. 8 any of the input beams from any layer can be routed to any of the output beams from any other layer without any combination being blocked by another. In the multiple layer embodiment of the optical switch 600 of this invention shown in Fig. 8, an upper cross shifting element 610 is optically disposed to receive the transmitted beams from the upper 4X4 embodiment of the optical switch 400. The upper cross shifting element 610 that is optically disposed to receive the transmitted beams from the upper 4X4 embodiment of the optical

switch 400 includes four sections 611, 612, 613, 614. Each of sections 611, 612, 613, 614 of the first upper cross shifting element 610 includes a switchable deviating component (switchable grating) capable of deviating in an upper cross shifting direction one of the previous element transmitted beams. In the embodiment shown in Fig. 78, all the sections 611, 612, 613, 614 of the first upper cross shifting element 610 are capable of deviating in an upper cross shifting direction one of the previous element transmitted beams. The upper cross shifting direction has a component directed towards the lower directing elements (that is, a component perpendicular to the plane containing the beams for upper 4X4 embodiment of the optical switch 400 and the previous element transmitted beams). Three lower cross shifting elements 660, 670, 680 are disposed below the first upper cross shifting element 610. Each lower cross shifting element 660, 670, 680 is disposed below the previous lower cross shifting element 660, 670, 680. Each lower cross shifting element 660, 670, 680 is optically disposed to receive the transmitted beams from each replica of the 4X4 embodiment of the optical switch of this invention 481, 482, 483, which are disposed below the upper 4X4 embodiment of the optical switch 400. Each lower cross shifting element 660, 670, 680 includes four sections and each section has a switchable deviating component (switchable grating) capable of deviating in a cross shifting direction one of the transmitted beams from the corresponding replica of the 4X4 embodiment of the optical switch 481, 482, 483. All the sections of the first lower cross shifting element 660 are capable of deviating one of the corresponding transmitted beams in a manner similar to that of the upper cross shifting element 610. In the embodiment shown in Fig. 8, all the sections of the second lower cross shifting element 670 are capable of deviating in an second lower cross shifting direction one of the transmitted beams from the corresponding replica of the 4X4 embodiment of the optical switch 482. The second lower cross shifting direction has a component directed towards the upper directing elements. All the sections of the third lower cross shifting element 680 are

capable of deviating one of the corresponding transmitted beams in a manner similar to that of the second lower cross shifting element 670.

Please replace the third paragraph on page 19, continuing onto page 20, and the second paragraph on page 20 with the following amended paragraphs:

A further embodiment 700 of the multiple input optical switch of this invention is shown in Fig. 9. In the embodiment 700 of the multiple input optical switch of this invention shown in Fig. 9, switching is controlled by the application of voltages from voltage sources 470, such as voltage source C11, to switchable diffraction gratings 711, 714, 721, 722, ~~724~~723, 724, 731, 732, 733, 734, 741, 742, 743, 744, 752, 753. In the embodiment 700 of the multiple input optical switch of this invention shown in Fig. 9 each directing element includes two groups of sections. In each group, each section includes a switchable grating (deviating element) having the same blazing state capable of deviating an incident beam in a direction consistent with the same blazing state. Hereinafter, a direction consistent with a first blazing is referred to as a first direction, and so forth. Selected switchable elements are disabled (or, equivalently, absent).

Referring to Fig. 9, the first directing element 710 receives two input beams 401, 402 at the first group of sections. The first section in the first group has a switchable volume grating 711 capable of deviating the first input beam 401 in the first direction. The second group of sections in the first directing element 710 receives two input beams 403, 404. The second group of two sections is similar to the first group of two sections. The second section in the second group has a switchable grating 714 capable of deviating the corresponding input beam ~~208~~ 404 in the second direction.

Please replace the only paragraph on page 21 with the following amended paragraph:

The pattern of the first two elements 710, 720 repeats in succeeding directing elements, from the third directing element 730 to the fifth directing element 750. That is, the third directing element 730 includes two groups of sections. In each group of section of the third directing element 730, the first section in each group has a switchable grating 731, 733 capable of deviating the corresponding second element transmitted beam in the first direction. The second section in each group has a switchable grating 732, 734 capable of deviating the corresponding second element transmitted beam in the second direction. The fourth directing element 740 also includes two groups of sections. In each group of section of the fourth directing element 740, the first section in each group has a switchable grating 741, 743 capable of deviating the corresponding third element transmitted beam in the second direction. The second section in each group of the fourth directing element has a switchable grating 742, 744 capable of deviating the corresponding third element transmitted beam in the first direction. The fifth directing element is similar to the first and third directing elements. That is, the fifth directing element 750 also includes two groups of sections and the first section in each group has a switchable grating 753 capable of deviating the corresponding fourth element transmitted beam in the first direction. The second section in each group from the fifth directing element ~~250~~ 750 has a switchable grating 752 capable of deviating the corresponding fourth element transmitted beam in the second direction. Any input can be routed to any output by applying the correct logic to the switchable diffraction gratings. An embodiment of this logic, but not limited to, is shown in the Table 2, where a "0" represents the state where the grating is "cleared" or non-diffracting, a "1" represents the state where the grating is diffracting, and a "-" represents the case where the state of the grating has no effect on that particular switch state.

Please replace the second paragraph on page 24 with the following amended paragraph:

An isometric view of the above described 4X4 embodiment 700 of the optical switch of this invention is shown in Fig. 10. A multiple layer embodiment 800 of the optical switch of this invention is shown in Fig. 11. A first lower directing element 810 is disposed below said first directing element 710. Successive lower directing elements 820, 830, 840, 850 are disposed below the corresponding upper directing element 720, 730, 740, 750. In such a manner a replica of the 4X4 embodiment of the optical switch 700 of this invention is disposed below the upper 4X4 embodiment of the optical switch 700. Similarly, several other replicas of the 4X4 embodiment of the optical switch 700 of this invention ~~are~~ can be stacked to obtain the multiple layer embodiment of the optical switch 800 of this invention shown in Fig. 11.